Abstract

A time-domain diffuse fluorescent-optical tomography system for breast tumor diagnosis

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Introduction

It is believed that the newly-developed diffuse optical tomography (DOT) technique has great potential for distinguishing between diseased and healthy tissue for early diagnosis of breast tumors. However, the relatively modest differences between the intrinsic optical properties of diseased and healthy breast tissue presents a great challenge to the reliability of this method. The difference can be effectively enhanced by administration of an exogenous fluorescent agent, such as the FDA approved ICG dye. For this purpose, a time-domain fluorescence-guided breast DOT methodology is under investigation.

Materials and Methods

A prototype time-domain diffuse fluorescence-optical tomography system has been developed. The system employs two pulsed diode lasers at NIR wavelengths of 780 nm and 830 nm respectively, dedicating to ICG dye. The laser light is coupled to a 1×32-fibre-switch that then sequentially directs the light to each of 32 source fibres, illuminating 32 sites on a semi-spherical imaging-chamber in which the breast is suspended with gentle compression. 32 detection fibres, the input ends of which are coaxially bundled with output ends of the source fibres, are connected to four 8×1-fibre-switches, whose four outputs are then routed to four PMT-TCSPC channels. Prior to each PMT detector is coupled a 6-hole motorised filter wheel that houses 4 neutral density filters of different optical density and one band-pass ICG-emitter filter.

Results and Discussion

A pilot validation of the system was performed using a solid cylindrical phantom which is made of epoxy resin mixed with TiO_2 particles for scattering and NIRD-09 dye for absorption. To emulate breast lesions, two holes are drilled and filled with ICG-Intralipid mixture. 16 coaxially-structured source-detection fibre bundles are placed evenly around the phantom on the mid-height plane. A Born normalised, featured-data algorithm based on the generalised pulse spectrum technique is used for image reconstruction. The resultant images reasonably reveal the fluorescent targets at the expected location.

Conclusion

A 32-channel time-domain diffuse fluorescence-optical tomography system has been constructed and evaluated. It has demonstrated that fluorescent yield and lifetime images of a tissue equivalent phantom can be simultaneously reconstructed from the time-resolved data-sets.

Reference paper as:
Gao, F., Zhang, W., Wu, L., Li, J., Wang, X., Zhang, L., Zhou. Z. and Zhao, H. (2012). A time-domain diffuse fluorescent-optical tomography system for breast tumor diagnosis (abstract), in: Proceedings of the 15th International Conference on Near Infrared Spectroscopy, Edited by M. Manley,C.M. McGoverin, D.B. Thomas and G. Downey, Cape Town, South Africa, p. 78.